PCT
WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : G01N 27/10, 23/08

A1

(11) International Publication Number: WO 90/0294]

(43) International Publication Date: 22 March 1990 (22.03.90

(21) International Application Number: PCT/NO89/00088

(22) International Filing Date: 30 August 1989 (30.08.89)

(30) Priority data: 8820687.5 1 September 1988 (01.09.88) GB

(71) Applicant *(for all designated States except US):* CHR. MICHELSENS INSTITUTT [NO/NO]; Fantoftvn. 38, N-5036 Fantoft (NO).

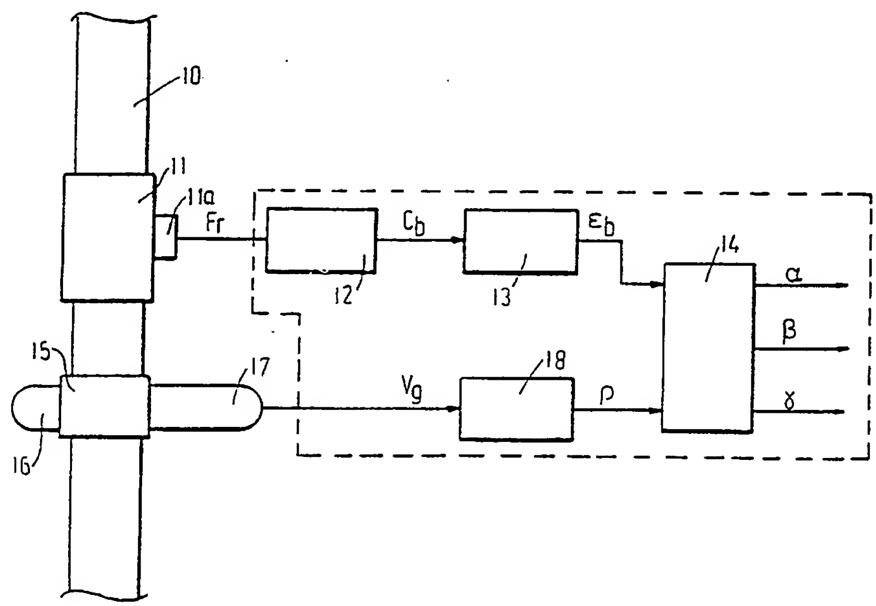
(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : HAMMER, Erling [NO/NO]; Saudalskleivane 66, N-5088 Mjølkeråen (NO). DYKESTEEN, Eivind [NO/NO]; Sandslikroken 10, N-5049 Sandsli (NO).

(74) Agent: A/S BERGEN PATENTKONTOR; Strandgt. 191, N-5000 Bergen (NO).

(81) Designated States: AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH (European patent), CM (OAPI patent), DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU (European patent), MC, MG, MI (OAPI patent), MR (OAPI patent), MW, NL (European patent), NO, RO, SD, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
With amended claims.

(54) Title: PROCESS AND INSTRUMENT FOR A THREE COMPONENT MEASUREMENT



(57) Abstract

A process and an instrument for determining the proportions of gas, water and oil in a gas/water/oil mixture. In the process the permittivity of the three-component mixture, during passing said mixture in a flow between two opposite electrodes, is measured by a capacitive non-penetrating first sensor, whereas the density of said flowing mixture is measured by a second sensor including a radioactive element and a gamma-radiation densitometer. The electronic signals received from said sensors being processed in a computer by incorporating specific equations therein and progressively determining the proportions of said three components in said three-component mixture. The instrument comprises an electrode capacitance sensor, including two opposite electrodes located at opposite sides of an intermediate concentrated mixture flow, a capacitance sensor head, a screen, a density meter including a radioactive element and a gamma-radiation densitometer, and a computer for processing the electronic signals and determining said proportions.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MR	Mauritania
BE	Belgium	GA	Gabon	MW	Malawi
BF	Burkina Fasso	GB	United Kingdom	NL	Netherlands
BG	Bulgaria	HU	Hungary	NO	Norway
BJ	Benin	IT	Italy	RO	Romania
BR	Brazil	JP	Japan	SD	Sudan
CA	Canada	KP	Democratic People's Republic of Korea	SE	Sweden
CF	Central African Republic			SN	Senegal
CG	Congo	KR	Republic of Korea	SU	Soviet Union
CH	Switzerland	LI	Liechtenstein	TD	Chad
CM	Cameroon	LK	Sri Lanka	TG	Togo
DE	Germany, Federal Republic of	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

PROCESS AND INSTRUMENT FOR A THREE COMPONENT MEASUREMENT.

This invention relates to a process and an instrument for determining the proportions of the components of a three-component mixture and in particular to a process and an instrument for determining the proportions of gas, water and oil in a gas/water/oil mixture.

This invention is applicable on different types of three-phase mixtures, but will herein be described mainly with reference to a three-phase mixture containing gas (g), water (w) and oil (o). Accordingly, the equations stated herein are referring to a three-phase mixture containing gas, water and oil and to the three specific components thereof. However, the equations stated herein are generic to different components, i.e. in general to three components stated as components g, w, and o, respectively.

In crude oil production, the fluid at the well head rarely, if ever, involves single phase single component flow. Usually it will contain crude oil, gas (in the free state and/or dissolved in the oil) and possibly water with the proportion of the latter tending to increase as production continues.

Measurements of the rates of hydrocarbon production from the wells in a field are required for reservoir management and production allocation. With such data, depletion of the reservoir can be undertaken with the aim of optimising total production over the field life. In addition the metering of the total production rate of oil and gas from a field is required for fiscal purposes. This demands a much higher degree of accuracy.

At present, crude oil production systems require separation of the gas, water and oil phases before satisfactory metering, for whatever reason, can be achieved.

Offshore production platforms of today, e.g. those in the North Sea, have a manifold system which allows the flow from a production well to be directed either to the main separators or to a test separator.

Thus at any time, although usually to a set cycle, the flow from a single well can be directed to a test separator where it is separated into gas, water and oil. Meanwhile the production from all other wells is manifolded together and processed in the main separation system. The flowrates of gas, water and oil are measured in the respective single phase lines from the test separator. All three flows are normally measured by using orifice plates, turbine meters or other conventional equipment. A considerable proportion of remaining oil reserves is believed to lie offshore under water depths in excess of 200 metres, in relatively small oil fields, and in hostile environments. As any one of these conditions intensifies, and more particularly when two or more are present together, the cost of conventional offshore recovery systems wherein drilling and production facilities are mounted on surface platforms rises rapidly and soon becomes uneconomic.

For this reason attention has been given to subsea systems where a favoured technique is to drill a number of wells close together and to mount the well head control equipment on the sea bed.

In any design for a new production facility the need for metering of the flows from individual wells, and of the bulk output of the field, must be considered in detail. With the advent of alternative production system concepts such as those outlined above it has become apparent that new methods of flow measurement are desirable to improve both the technical and economic viability of such projects.

One particular problem with multi-phase regimes is the variability of flow conditions in the line. Stratified flow, wavy flow, bubble flow, plug flow, slug flow and annular flow can all occur at various times in horisontal lines. Vertical flow avoids stratification, however.

The density of a three-component gas/water/oil mixture is given by:

$$\rho_m = \alpha\rho_g + \beta\rho_w + (1-\alpha-\beta)\rho_o \qquad [1]$$

where ρ_m is the density of the three-component mixture, ρ_g is the gas density, ρ_w is the water density and ρ_o is the oil density. This ρ_m is the density that is measured by a gamma-radiation densitometer. If we somehow know the water fraction β, we can calculate the gas fraction α from Eq. 1 as follows:

$$\alpha = \frac{\rho_m - \beta(\rho_w - \rho_o) - \rho_o}{(\rho_g - \rho_o)} \qquad [2]$$

Conversely if the gas fraction is known, Eq. 1 can be used to compute the water fraction β. From this it is obvious that a gamma-radiation densitometer alone cannot be used to measure either the gas or water fraction.

The permittivity of a three component mixture can be related to the component volume fractions by the following relationship:

$$\frac{1 - \varepsilon_b}{1 - \varepsilon_s} \left(\frac{\varepsilon_s}{\varepsilon_b}\right)^{1/3} = 1 - \alpha \qquad [3]$$

where α is the gas fraction, and ε_b is permittivity of the three-component mixture. ε_s is the permittivity of a two-component (oil/water component) of the three-component mixture, and is given by

$$\varepsilon_s = \frac{\varepsilon_o}{(1 - \beta_f)^{3-4.2 \cdot \beta_f^6 + 3\beta_f^{10}}} \qquad [3a]$$

where β_f is the water concentration in the two-component (oil/water component). This formula is a slight modification of Bruggemans formula for two-component mixtures. The actual water fraction of the three-component mixture is given by:

$$\beta = (1-\alpha)\,\beta_f \qquad [3b]$$

According to the present invention there is provided a

process for determining the proportions of the components of a three-component mixture, especially the proportions of gas, water and oil in a gas/water/oil mixture. The process of the invention is characterised in, during passing the three-component mixture in a flow through a spacing between two opposite electrodes, measuring the permittivity of said flowing mixture by a capacitive non-penetrating first sensor, measuring the density of said flowing mixture by a second sensor (gamma densitometer) including a radioactive element and a gamma radiation detector, processing electronic signals received from said sensors in a computer by incorporating specific equations therein, and progressively determining the proportions of said three components in said three-component mixture.

It is thus possible to determine in succession and with a adequate accuracy the three components of the mixture flow at rather short intervalls during the passage of the mixture flow in the spacing between the electrodes.

Further, according to the present invention there is provided an instrument for determining the proportions of the components in a three-component mixture, and especially the proportions of gas, water and oil in a gas/water/oil mixture. The instrument is characterised by a first electrode capacitance sensor, including two opposite electrodes located at opposite sides of an intermediate concentrated flow of said three-component mixture for measuring the permittivity of said three-component mixture, an capacitance sensor head for reducing or eliminating impedance between the electrodes and a screen, a density meter including a radioactive element and a gamma radiation detector for determining the density of the mixture, and a computer for processing the electronic signals and determining the proportions of said three components (gas, water and oil) in said three-component mixture.

The algorithm in the computer of the instrument of the present invention will be like this:

1. Choose a value for β.
2. Calculate α using β and the measured density of the mixture (Eq. 2).

3. From α and the measured permittivity of the mixture, calculate a new value from β using the three-component permittivity formula (Eq.3).

4. Go to step 2 and repeat the process a predetermined number of times, or use some convergence criteria to stop the iteration.

The accuracy of the final result depends on a number of factors. These are briefly discussed below.

(a) The accuracy depends strongly on how accurate the densitiy of the crude oil is known. The density depends on the temperature and pressure, and therefore it will be necessary to compensate for temperature and pressure variations. The density changes with pressure because of the compressibility of the oil, and also because of changing gas/oil-ratio with changing pressure.

(b) The density of the water must also be known with high precision. The water density depends strongly on the salinity, and therefore it has to be measured in each case. For water the variation in density with respect to temperature and pressure probably can be ignored for reasonable temperature and pressure variations.

(c) The density of the gas also has to be known, and also this quantity depends on temperature, pressure and on its composition. At atmospheric pressure the gas density will only be about $1kg/m^3$, and can be neglected compared to the densities of oil and water. At substantially higher pressures this can not be neglected and compensation must be made.

(d) The permittivity of the crude oil should be known within 1% in order to avoid significant errors because of this factor.

(e) Finally the accuracy will depend on the accuracy of the densitometer and the capacitance measurement.

Situating the sensor inline in the production system means that very little pressure drop can be tolerated across the sensor. Furthermore in a riser, erosion can be very high and therefore the sensor should ideally be non-intrusive.

Taking these factors into acount the electrodes of the sensor head are in the shape of arcuate electrode plates incorporated in a tube forming sensor head each of said electrodes facing the mixture flow in said sensor head. In the following the sensor is denoted as a surface plate sensor.

The sensor head is ring shaped or sleeve shaped and incorporate a pair of radially innermost electrodes and a radially outermost screen and an intermediate volume containing electric insulating material. The screen is at earth potential. The arcuate electrode plates may be spaced from the mixture flow by a layer of electrically insulated material.

In the surface plate electrode sensor, the electrical field penetrates through the whole measuring section, making the sensor sensitive to the flow in the centre of the pipe as well as along the pipe wall. Careful choice of the electrode opening angle ensures that every part of the measuring volume will have the same effect on total sensor impedance.

It can be shown that with respect to homogeneity of the electric field, the optimum electrode opening angle is between 60° and 90°. The sensitivity of a surface plate sensor with such an opening anlge will also be good.

In accordance with a preferred embodiment of the invention the electrodes, circumferencially along the inner surface of the tube forming sensor head, are mutually spaced by an opening angle of between approximately 60 to 90°.

The sensor head also reduces or eliminates impedance between the electrodes. One way of achieving this is by providing the sensor head in each spacing between the electrodes with a strip shaped guard with an extension of some few arcuate degrees, and by connecting said guard strips at the potential of said first electrode.

It is preferred that said guard strips are incorporated in a ring shaped guard surrounding the edges of one of said two electrodes.

Suitable electrically insulating material is a ceramic or a polyurethane or other material having good resistance to erosion and low thermal expansion.

The electrodes are made of an electrically conducting material including stainless steel, conducting ceramic and other suitable material.

The present invention, i.e. the process as well as the instrument of the invention, has the following advantages:

- non intrusive -
- measure complete flow through pipe, no sampling -

- real time -
- no moving parts -
- reliable with low maintenance.

The invention is illustrated by, but not limited with reference to Figures 1 to 4 of the accompanying drawings wherein

Figure 1 is a schematic representation of a system incorporating a capacitance sensor and a density sensor, i.e. a gamma-densitometer to calculate the flow composition.

Figure 2 is a capacitance measurement transmitter illustrated in Figure 1.

Figure 3 is a section through a sensor.

Figure 4 is a plane view of one of the electrodes and its associated guard.

With reference to Figure 1, a three-component mixture of gas, water and oil flows through a line 10 incorporating a capacitance sensor 11, i.e. a first sensor, which measures the permittivity of the mixture. A transmitter 11a feeds signals from the first sensor 11 to a first data processing unit 12 and further to a second data processing unit 13 incorporated in a computer 14. Said units can incorporate a display of the relative proportions of the three-component mixture.

A second sensor 15, i.e. a gamma densitometer, is incorporated in the flowline 10 in the vicinity of the first sensor 11. The gamma densitometer 15 include a gamma meter radioactive source 16. Herein a ceasium isotope is selected, but other isotopes such as americium isotope could also be used. Further, the gamma densitometer 15 include a gamma meter detector 17. The gamma meter radioactive source 16 and the gamma meter detector 17 are located at opposite sides of the flowline 10 clamped to a pipe forming sensor head of said second sensor 15. The output of the gamma densitometer, in combination with the output of the first sensor 11, is used to calculate the fractions of the mixture and an accurate result may be obtained rather easily.

The output frequency F_r from the capacitance measurements electronics is converted from a first data processing unit 12 into a digital value C_b which represents the sensor capacitance. The relationship between C_b and F_r is established through calibration of the measurement electronics, and the calibration curve is stored in the computer memory. The computer also stores

a calibration curve for the capacitance sensor 11. This is herein used to convert the measured capacitance C_b in a second data processing unit 13 into a value for the permittivity of the mixture, ε_b.

The gamma meter detector 17 of the second sensor 15 gives out a signal V_g, which is proportional to the density of the mixture flowing inside the pipe. A data processing unit 18 of said computer is converting the signal V_g to the digital value which is the measured density of the flowing mixture. This value from unit 18 and the value $_b$ from unit 13 is further processed in a common unit 14 of the computer. The unit 14 contains a mathematical model relating measured permittivity and measured density of the flowing mixture, to the proportions of gas (α), water (β) and oil (γ).

The capacitance transmitter 11a is illustrated in further details in Figure 2. The sensor capacitance C_1 provides a triangular wave v_1 which is generated by integration of a square wave v_2. In turn this triangular wave v_1 is used as the input to a square wave generator. The illustrated closed loop constitutes a sesonance system where the resonance frequency f is given by equation 5:

$$f = k \frac{1}{C_1}$$

wherein k is a constant determined by R_1 and zener diodes Z_3 and Z_4 and C_1 is the sensor capacitance.

With reference to Figure 3 there is illustrated a section of a sensor head 20 of the first sensor 11. This sensor head 20 comprises two electrodes 21 and 22 connected to terminals 21a and 22a and a guard 25 connected to a terminal 25a. An outer screen 26 made of steel is connected to earth and provides a housing for the sensor head and surrounds an insulation 27 wherein there is incorporated the electrodes 21,22 and the guard 25. The insulation 27 is leaving a central cavity 28 for fluid flow.

More detailed the electrodes 21,22 and the guard 25 are insulated from the fluid flow by means of a radially innermost insulation layer 27a made of a first ceramic material, such as

sintered alumina (aluminium oxyd). In the spacing between said radially innermost insulation layer 27a and the radially outermost screen 26 there is a main insulation layer 27b made of a second ceramic material, such as "Ceramite" delivered from Elkem Materials A/S, Norway.

In practice the insulation layer 27b, the electrodes 21,22 and the guard 25 is being enveloped between the inner insulation layer 27a and the outer screen 26. As illustrated in Figure 3 connections 21a,22a,25a are passing from its associated electrode 21,22 and guard 25 respectively via the insulation layer 27b to a connecting box 26a at one side portion of the screen 26.

In Figure 4 is illustrated the electrode 22 and the guard 25 in a plane folder position. The electrode 22 (as well as the electrode 21) is of rectangular shape. It is evident from Figure 4 that the guard 25 is rectangularly ring shaped and spaced from the electrode 22 by a minor gap of say 5 mm. The electrodes 21,22 and the guard 25 is in a preferred embodiment during production thereof, applied in a rather thin walled layer directly at the radially outer surface of the radially innermost insulation layer 27a and is hence covered by the radially outermost insulation layer 27b.

Claims.

1. Process for determining the proportions of the components of a three-component mixture, especially the proportions of gas, water and oil in a gas/water/oil mixture, characterised in

during passing the three-component mixture in a flow through a spacing between two opposite electrodes, measuring the permittivity of said flowing mixture by a capacitive non-penetrating first sensor and the density of said flowing mixture by a second sensor including a radioactive element and a gamma-radiation densitometer,

processing electronic signals received from said sensor in a computer by incorporating the following equations therein:

$$\frac{1-\varepsilon_b}{1-\varepsilon_s}\left(\frac{\varepsilon_s}{\varepsilon_b}\right)^{1/3} = 1-\alpha \qquad [3]$$

where α is a first component (gas), ε_b is the permittivity of the three-component mixture, ε_s is the permittivity of a two-component mixture of a second (water) and a third (oil) component and is given by:

$$\varepsilon_s = \frac{\varepsilon_o}{(1-\beta_f)^{3-4.2\cdot\beta_f^{6}+3\beta_f^{10}}} \qquad [3a]$$

where β_f is the concentration of the second component in said two-compoent mixture and the actual fraction of the second component in the three-component mixture is given by:

$$\beta = (1-\alpha)\ \beta_f \qquad [3b]$$

and

$$\alpha = \frac{\rho_m - \beta(\rho_w - \rho_o) - \rho_o}{(\rho_g - \rho_o)} \qquad [2]$$

where ρ_g is the gas density, ρ_w is the water density, ρ_o is the oil density, and ρ_m is the density that is measured by a gamma-radiation densitometer, and

progressively determining the proportions of said three components in said three-component mixture.

2. Instrument for determining the proportions of the components in a three-component mixture, and especially the proportions of gas, water and oil in a gas/water/oil mixture, c h a r a c t e r i s e d i n

a) a first electrode impedance capacitance, including two opposite electrodes located at opposite sides of an intermediate concentrated flow of said three-component mixture for measuring the permittivity of said three-component mixture,

b) an impedance sensor head for reducing or eliminating impedance between the electrodes and a screen,

c) a density meter including a radioactive element and a gamma-radiation densitometer for determining the density of the mixture, and

d) a computer for processing the electronic signals and determining the proportions of said three components (gas, water and oil) in said three-component mixture.

3. Instrument according to claim 2, c h a r a c t e r i s e d i n

that the electrodes of the sensor head are in the shape of arcuate electrode plates incorporated in a tube forming sensor head, each of said electrodes facing the mixture flow in said sensor head.

4. Instrument according to one of claims 2 or 3, c h a r a c t e r i s e d i n

that the sensor head is ring shaped or sleeve shaped and incorporate a pair of radially innermost electrodes and a radially outermost screen and an intermediate volume containing electrically insulating material.

5. Instrument according to one of claims 3 to 4, c h a r a c t e r i s e d i n

that the screen is at earth potential.

6. Instrument according to one of claims 3 to 5, c h a r a c t e r i s e d i n

that the arcuate electrode plates are spaced from the mixture flow by a layer of electrically insulated material.

AMENDED CLAIMS

[received by the International Bureau on 13 February 1990 (13.02.90) original claim 2 amended;other claims unchanged (1 page)]

2. Instrument for determining the proportions of the components in a three-component mixture, and especially the proportions of gas, water and oil in a gas/water/oil mixture, c h a r a c t e r i s e d i n

a non-intrusive measurement instrument comprising

a) a first electrode impedance capacitance, including two opposite electrodes located at opposite sides of an intermediate concentrated flow of said three-component mixture for measuring the permittivity of said three-component mixture,

b) an impedance sensor head for reducing or eliminating impedance between the electrodes and a screen,

c) a density meter including a radioactive element and a gamma-radiation densitometer for determining the density of the mixture, and

d) a computer for processing the electronic signals and determining the proportions of said three components (gas, water and oil) in said three-component mixture.

3. Instrument according to claim 2, c h a r a c t e r i - s e d i n

that the electrodes of the sensor head are in the shape of arcuate electrode plates incorporated in a tube forming sensor head, each of said electrodes facing the mixture flow in said sensor head.

4. Instrument according to one of claims 2 or 3, c h a r a c t e r i s e d i n

that the sensor head is ring shaped or sleeve shaped and incorporate a pair of radially innermost electrodes and a radially outermost screen and an intermediate volume containing electrically insulating material.

5. Instrument according to one of claims 3 to 4, c h a r a c t e r i s e d i n

that the screen is at earth potential.

6. Instrument according to one of claims 3 to 5, c h a r a c t e r i s e d i n

that the arcuate electrode plates are spaced from the

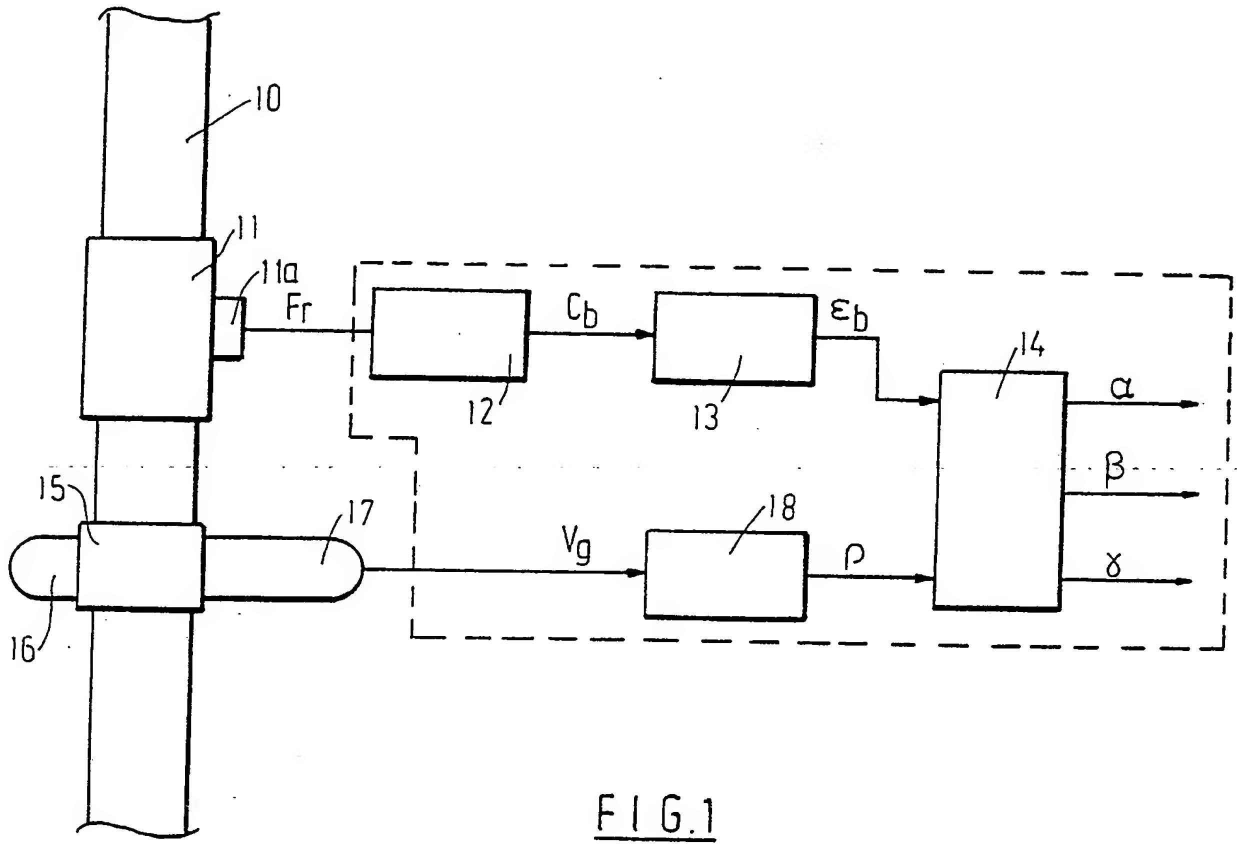


FIG.1

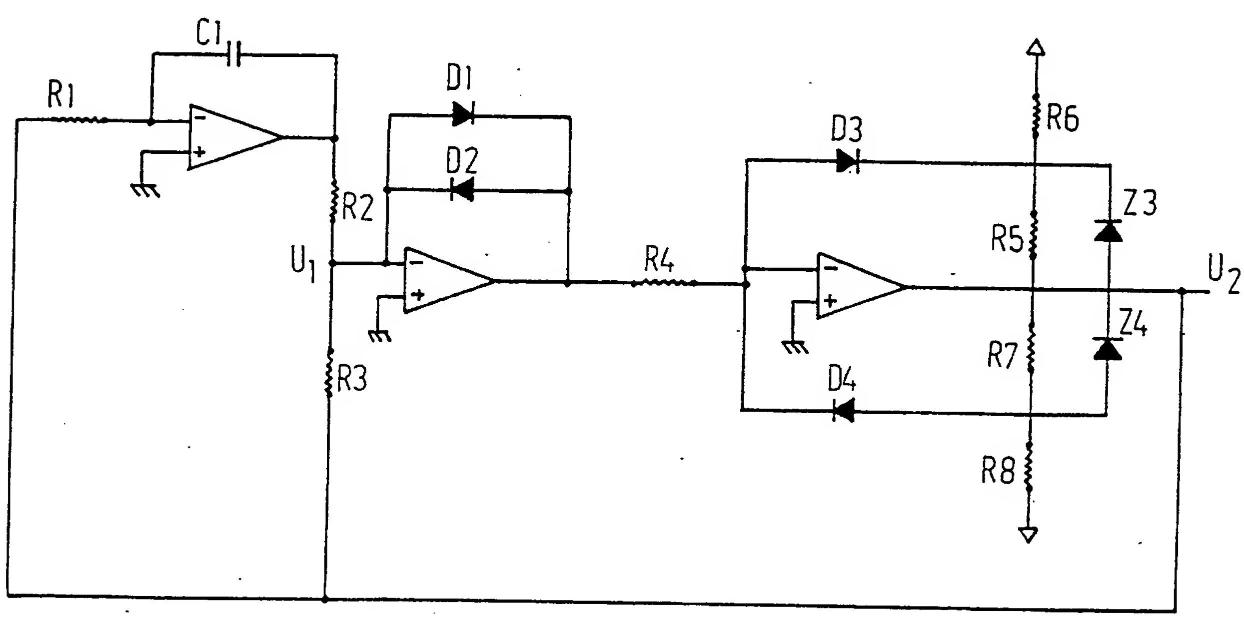


FIG.2

SUBSTITUTE SHEET

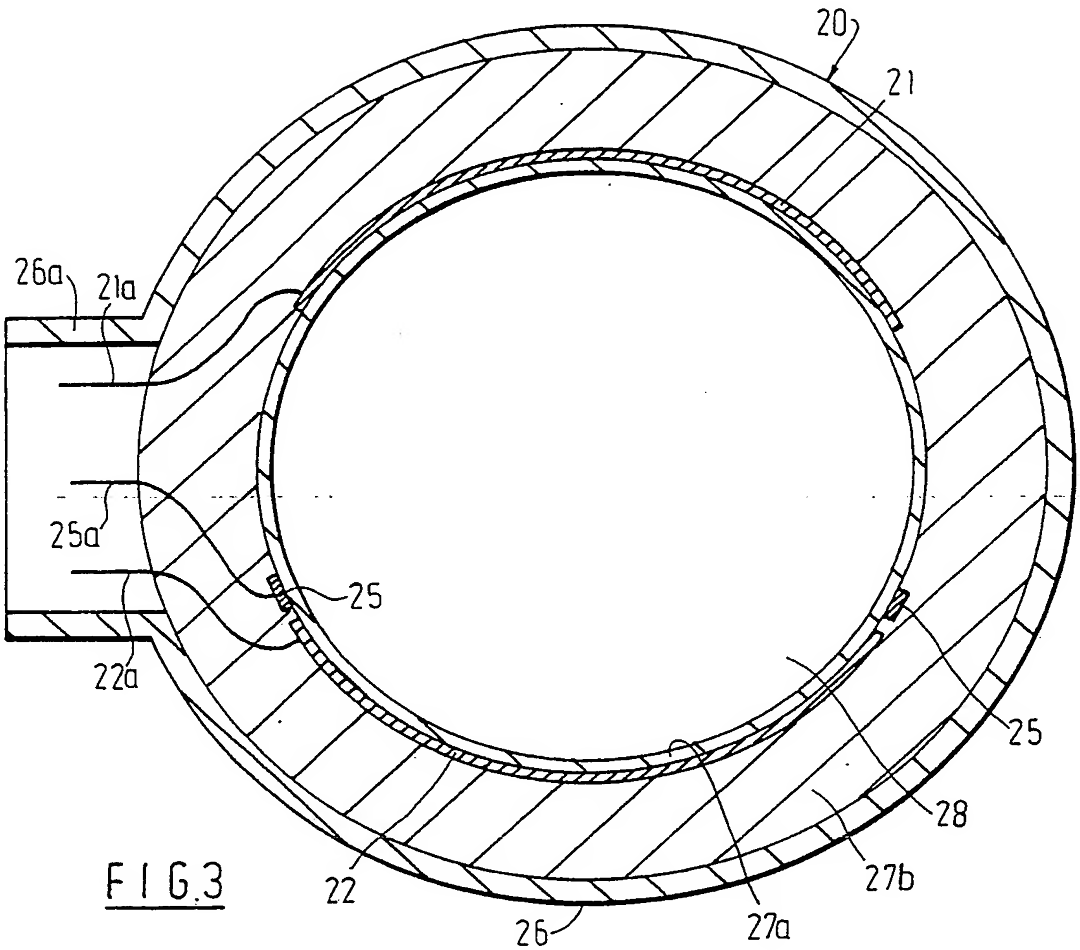


FIG.3

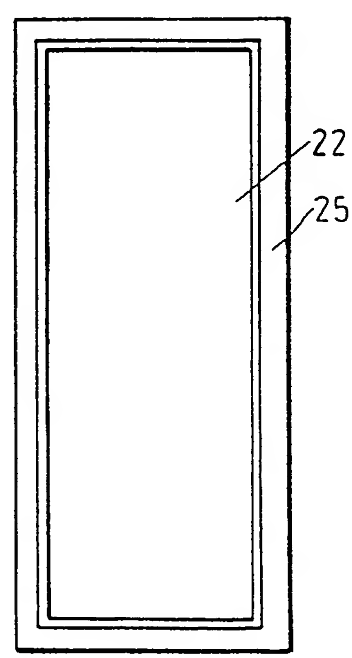


FIG.4

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 89/00088

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC
IPC4: G 01 N 27/10, 23/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC4	G 01 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	J. Phys. E: Sci. Instrum., Vol. 18, 1985 (Great Britain) Eivind Dykesteen et al: "Non-intrusive three-component ratio measurement using an impedance sensor ", --	1,2
Y	US, A, 3675121 (DON D. THOMPSON) 4 July 1972, see the whole document --	1
Y	US, A, 4644263 (IRVIN D. JOHNSON) 17 February 1987, see the whole document --	2
Y	GB, A, 2088050 (ERNEST JOHN MICHAEL KENDALL) 3 June 1982, see the whole document --	2

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
5th December 1989	1989 -12- 0 8
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Eva Iversen Hasselrot

International Application No. PCT/NO 89/00088

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4713603 (RICHARD THORN) 15 December 1987, see the whole document --	1-11
A	DE, A, 1798370 (ALCO STANDARD CORP.) 20 January 1972, see the whole document --	2-11
A	DE, C2, 2533943 (GEORGE KENT LTD.) 21 March 1985, see the whole document --	2-11

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/NO 89/00088

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 3675121	04/07/72	FR-A-B-	2096502	18/02/72
		DE-A-	2120744	30/12/71
		GB-A-	1331327	26/09/73
		US-A-	3778706	11/12/73
US-A- 4644263	17/02/87	NONE		
GB-A- 2088050	03/06/82	JP-A-	57116240	20/07/82
		DE-A-	3146253	21/10/82
US-A- 4713603	15/12/87	WO-A-	85/02016	09/05/85
		EP-A-B-	0160673	13/11/85
		JP-T-	61500985	15/05/86
		CA-A-	1236992	24/05/88
		DE-A-	3476122	16/02/89
DE-A- 1798370	20/01/72	DE-A-	1598633	29/10/70
		US-A-	3539471	10/11/70
DE-C2- 2533943	21/03/85	NL-A-	7509233	04/02/76
		US-A-	3993945	23/11/76
		GB-A-	1517697	12/07/78
		JP-A-	51039096	01/04/76